DLR-AG Facilities & Research Plans

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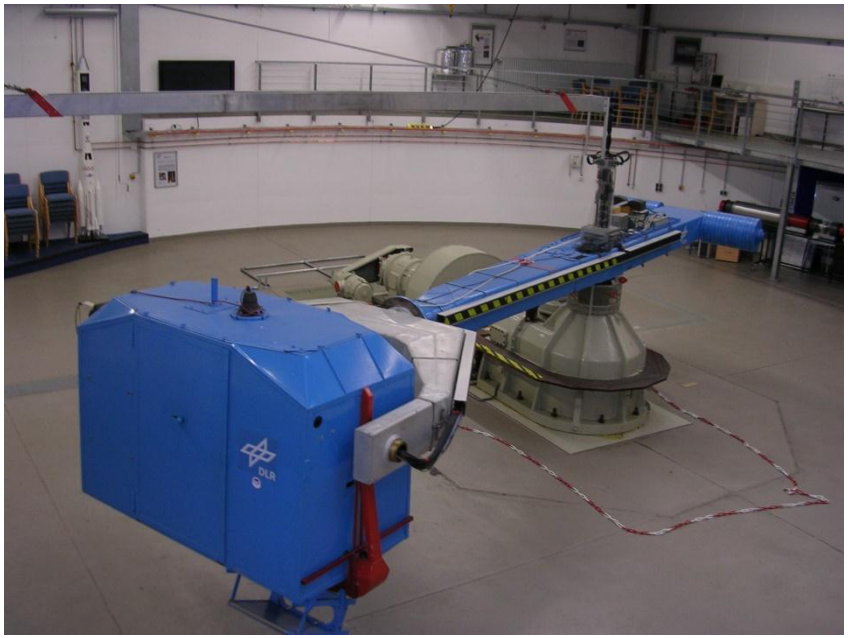
AG Facilities at DLR – Overview and status

- Long Arm Human Centrifuge:



Closed in 2013 after more than 60 years of service!

AG Facilities at DLR – Overview and status

- ESA Short Arm Human Centrifuge:

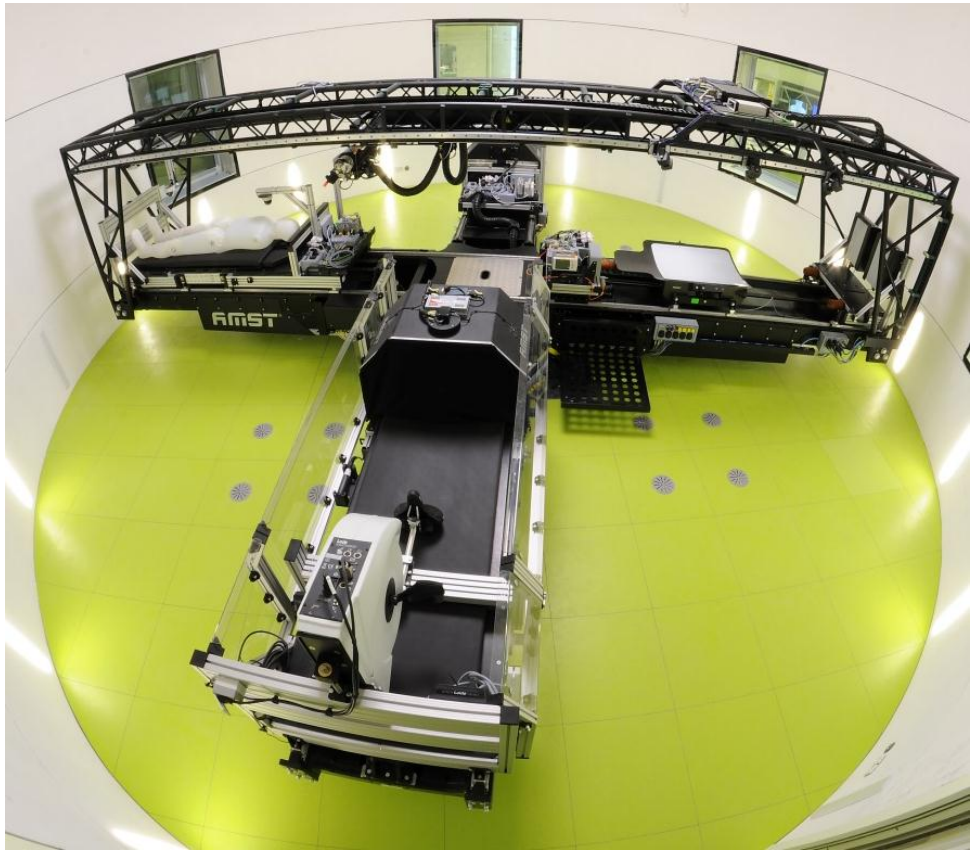
Built	2008
Max. radius at outer perimeter	280 cm
Max. centrifugal acceleration	4.5 *g*
Max. g-alteration rate	0.325 g/s
Max. revolution of centrifuge rotor	39 rpm
Number and type of nacelles	2 beds 2 seats
Drive system	Three-phase motor
Power	75 kW
Max. payload	550 kg

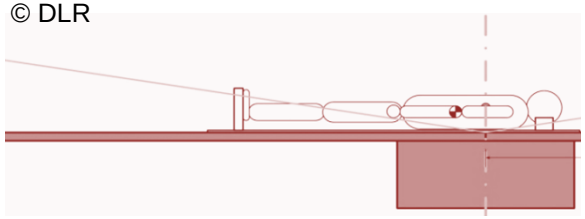
:envihab

Research facility :envifuge – *technical data*

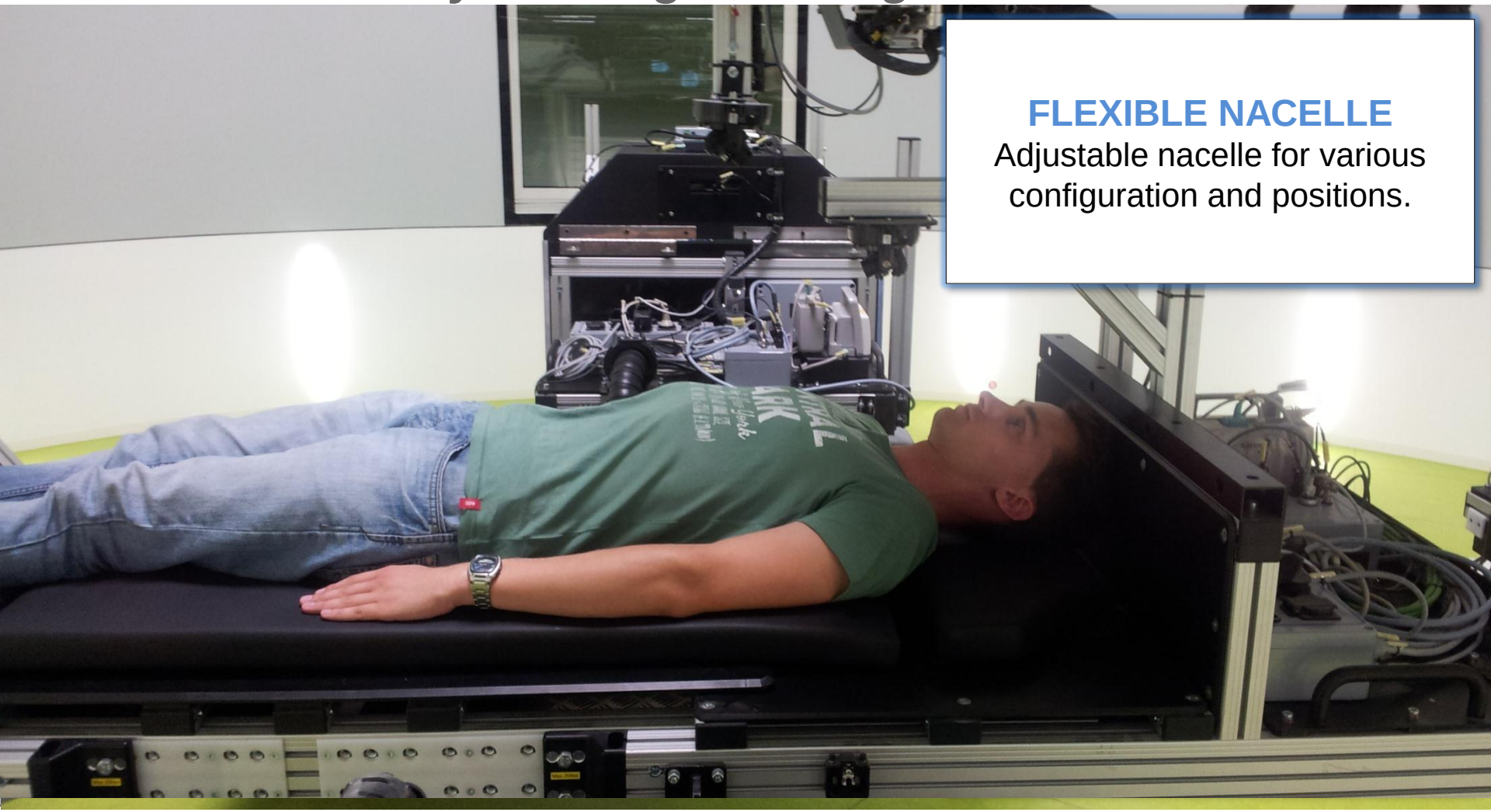
Radius	380 cm
Max. acceleration	6*g* @ 370 cm
Max. onset rate (from 0*g* to 6*g*)	0.133 rad/s^2 (≈ 0,2*g*/s)
Drive system	Torque drive, water-cooled
Power	30 kW
Max. angular velocity	4 rad/s (≈ 38 rpm)
Sound emission	< 40dB
Subjects height	150 – 210 cm
Max. subject weight	150 kg
Max. payload	800 kg
Nacelle translation speed	10 mm/s

No balancing needed.
Extreme smooth running.





Research facility :envifuge – *configurations*

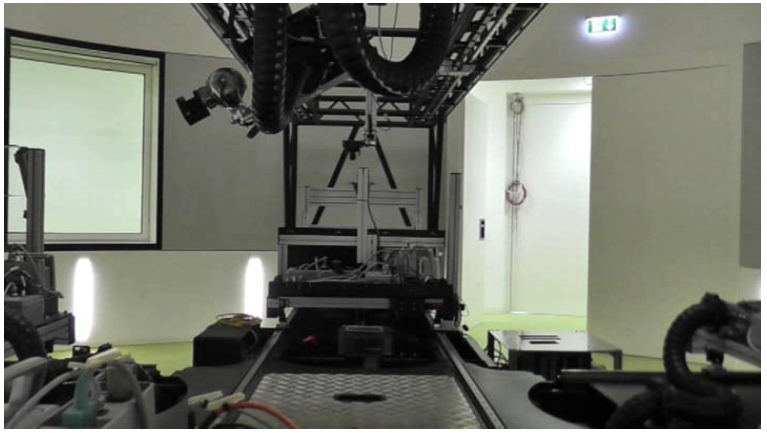


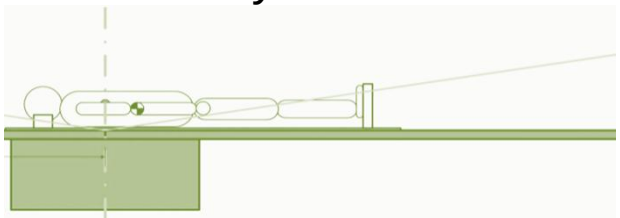
FLEXIBLE NACELLE

Adjustable nacelle for various configuration and positions.

Research facility :envifuge – *nacelles*

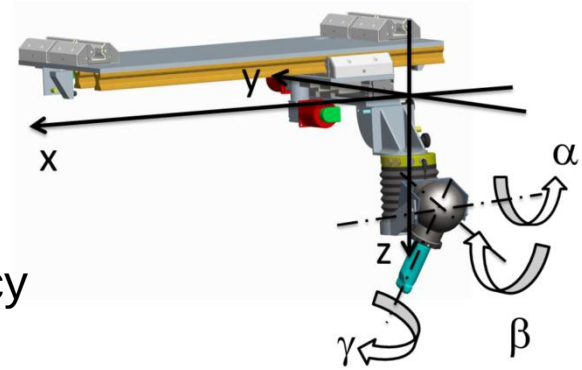
- Traveling distance of nacelles:
  - Main arm: 2,5 m
  - Secondary arm: 0,25-0,90 mm (depending on subject height)
- Extremely short radius set-up possible:
  - Heart @ center of rotation
  - Head @ center of rotation
- Highly configurable:
  - Various mounting points
  - Auxiliary arms completely exchangeable
  - Auxiliary arms can be tilted

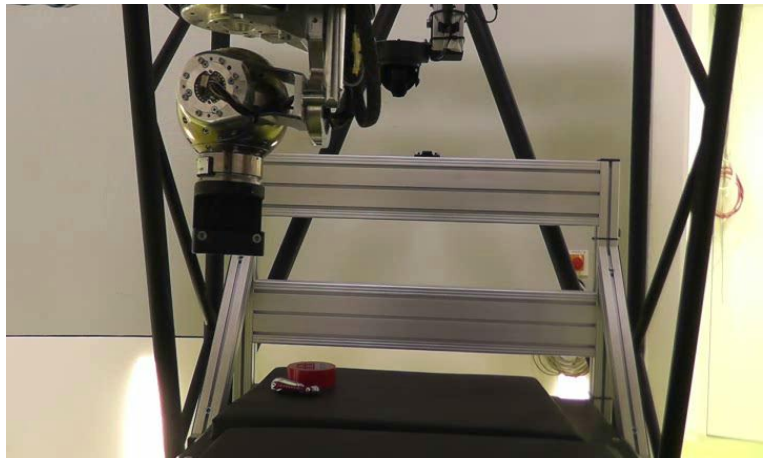


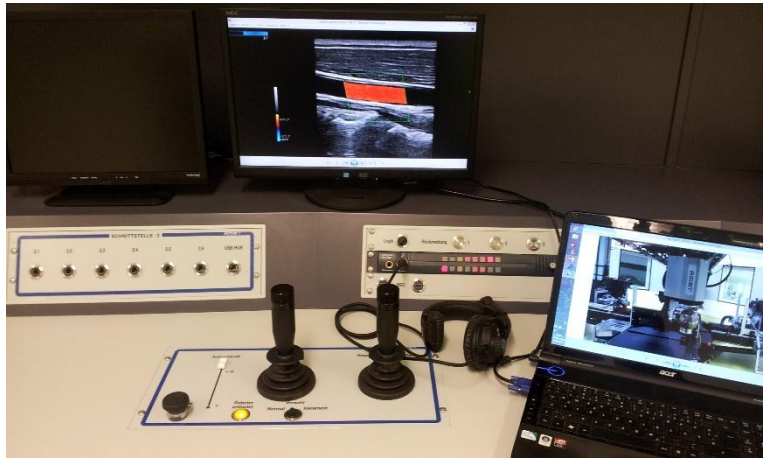


Research facility :envifuge – *robot arm*

- Axis:
  - 6 degrees of Freedom
- Speed
  - x, y: 30mm/s
  - z: 10mm/s
  - α, β, χ: 5°/s
- Payload
  - max. 1kg
- Position accuracy
  - +/- 1mm
- Contact force
  - Adjustable. Depends on probe geometry and safety settings.
- Interface
  - Active Contact Flange
  - Powerball







First Test Run – Jumps and Squats (1 g @ feet-level)

Future applications for space research on :envifuge

- Complex physical exercises under AG
  - Loading of bones and muscles
  - Neuro-vestibular effects (motion sickness)
  - Cardiovascular response with respect to the acceleration-gradient

- Comparison between Long arm and short arm centrifuge
- Short radius set up for realistic simulation of in-flight SRC´s
  - Radius below 1.5m
  - Head position close to center of centrifugation
  - Multiple exercises (whole body training)

- Ultrasound examination of inner organs (e.g. heart) during centrifugation

- Both SRC´s are available for National centrifuge program (NZP) and ESA Ground based facility program (CORA)
- International collaboration is very welcome

From a research- to a training-tool

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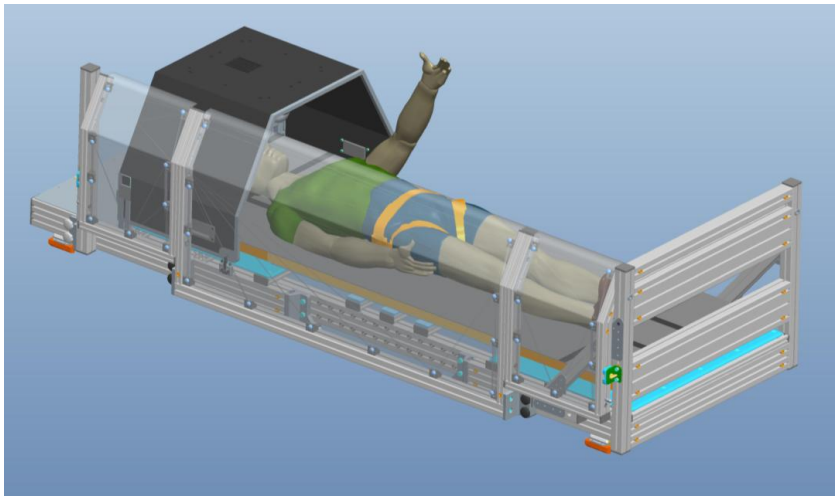
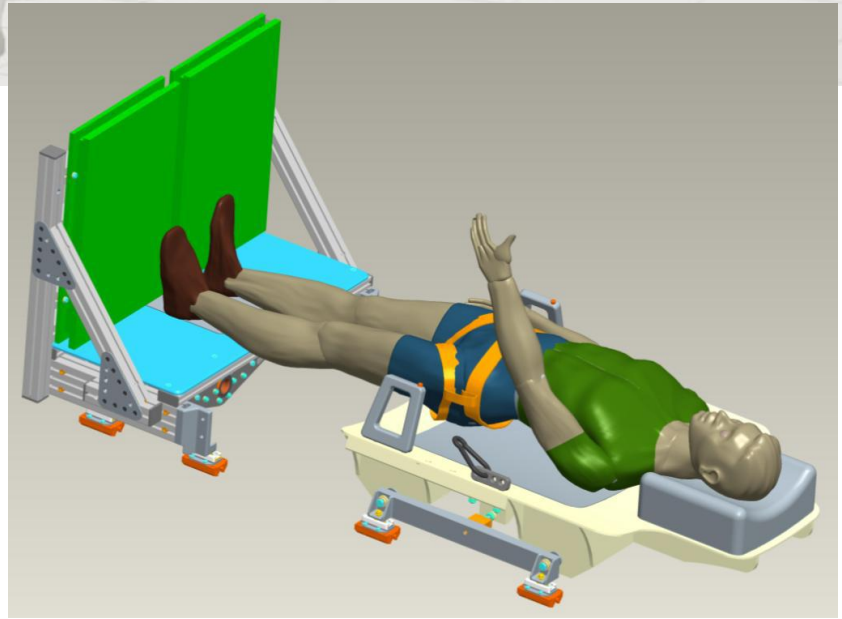
Standard Nacelle

- The standard nacelle is designed for standard centrifuge runs. It can handle subjects with a body height from 1,50m to 2,10m and a body weight of 150kg at lateral or supine position.
- Additional windshields can be mounted to avoid unwanted air-stream.
- Instead of the force plate, a vibration plate can be mounted.



Jump platform

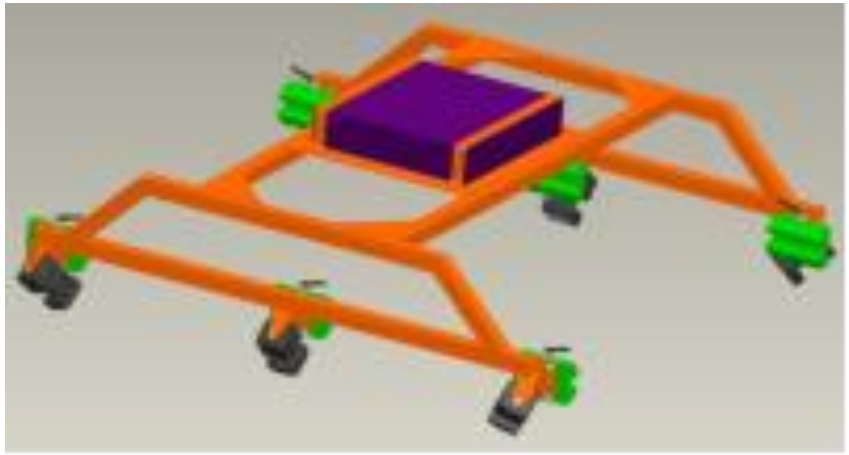
- Alternatively to the standard nacelle there is a lightweight sled available for performing squats and jumps.
- At the foot end there are two triaxial force plates which measures ground reaction force individually between left and right foot.



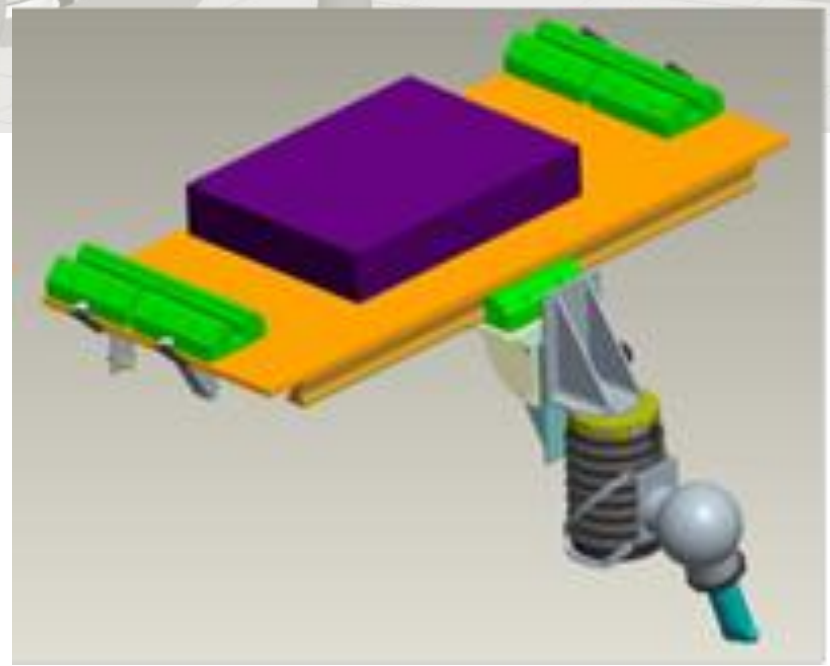
Motion Capturing System

- It consists of six cameras which covers almost 50% of the body. This system is mounted on a sled which can be moved along the lattice arm to position the MCS to capture the movement at the respective region of interest.

- VICON System
- 6 Bonita Cameras
- Body Builder Software
- Gigaswitch



Robotic arm



- The robotic arm is attached to a sled which can be positioned along the lattice arm. It consists of a mounting with a Powerball at the end.
- The Powerball has a clamping mechanism which can be equipped e.g. an ultrasound probe. This robotic arm is controlled from a special console in the control room.

Ergometer nacelle

- Lode Ergometer
- Remote Control
- Feedback